Mr. Shor

SBN 583730 122/5

REPORT

OF THE

SECRETARY OF STATE,

ON THE SUBJECT OF ESTABLISHING A UNIFORMITY

IN THE

WEIGHTS, MEASURES AND COINS

OF THE

UNITED STATES.

PUBLISHED BY ORDER OF THE HOUSE OF REPRESENTATIVES.

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M,DCC,XC.

NEW-YORK, *July* 4, 1790.

S I R,

IN *obedience to the order of the Houſe of Repreſentatives, of January* 15*th, I have now the honor to incloſe you a* REPORT *on the ſubject of* MEASURES, WEIGHTS, *and* COINS. *The length of time which intervened between the date of the order and my arrival in this city, prevented my receiving it till the* 15*th of April; and an illneſs which followed ſoon after, added, unavoidably, ſome weeks to the delay; ſo that it was not till about the* 20*th of May that I was able to finiſh the Report. A deſire to leſſen the number of its imperfections, induced me ſtill to withhold it awhile, till, on the* 15*th of June, came to my hands, from Paris, a printed copy of a propoſition made by the Biſhop of* AUTUN, *to the National Aſſembly of France, on the* *ſubject of Weights and Meaſures; and three days afterwards I received through the channel of the public papers, the ſpeech of* Sir John Riggs Miller, *of April 13th, in the Britiſh Houſe of Commons, on the ſame ſubject. In the Report which I had prepared, and was then about to give in, I had propoſed the latitude of 38°, as that which ſhould fix our ſtandard, becauſe it was the medium latitude of the United States; but the propoſition before the National Aſſembly of France, to take that of 45° as being a middle term between the Equator and both Poles, and a term which might conſequently unite the nations of both hemiſpheres, appeared to me ſo well choſen, and ſo juſt, that I did not heſitate a moment to prefer it to that of 38°. It became neceſſary of courſe to reform all my calculations to that ſtandard; an operation which has been retarded by my other occupations.*

Theſe circumſtances will, I hope, apologize for the delay which has attended the execution of the order of the Houſe: And, perhaps, a diſpoſition on their part, to have due regard to the proceedings of other nations, engaged on the ſame ſubject, may induce them ſtill to *defer deciding ultimately on it till their next ſeſſion. Should this be the caſe, and ſhould any new matter occur in the mean time, I ſhall think it my duty to communicate it to the Houſe, as ſupplemental to the preſent Report.*

I have the Honor to be,

With Sentiments of the moſt profound Reſpect,

S I R,

Your moſt obedient, and

Moſt humble Servant,

Thomas Jefferſon.

The SPEAKER of the Houſe of Repreſentatives.

In the HOUSE of REPRESENTATIVES of the UNITED STATES.

FRIDAY, the 15th of *January*, 1790.

Ordered,

That it be referred to the Secretary of State to prepare and report to this Houſe a proper Plan or Plans for eſtabliſhing Uniformity in the Currency, Weights and Meaſures of the United States.

Extract from the Journal,

John Beckley, Clerk.

The SECRETARY OF STATE, *to whom was referred, by the* HOUSE OF REPRESENTATIVES, *to prepare and report a proper* PLAN *or* PLANS *for eſtabliſhing Uniformity in the* CURRENCY, WEIGHTS *and* MEASURES *of the United States, in obedience thereto, makes the following*

REPORT:

TO obtain uniformity in Meaſures, Weights and Coins, it is neceſſary to find ſome meaſure of invariable length, with which, as a ſtandard, they may be compared.

THERE exiſts not in nature, as far as has been hitherto obſerved, a ſingle ſubject, or ſpecies of ſubject, acceſſible to man, which preſents one conſtant and uniform dimenſion.

THE globe of the earth itſelf, indeed, might be conſidered as invariable in all its dimenſions, and that its circumference would furniſh an invariable meaſure; but no one of its circles, great or ſmall, is acceſſible to admeaſurement through all its parts; and the various trials to meaſure definite portions of them, have been of ſuch various reſult, as to ſhew there is no dependence on that operation for certainty.

MATTER then, by its mere extenſion, furniſhing nothing invariable, its MOTION is the only remaining reſource.

THE motion of the earth round its axis, though not abſolutely uniform and invariable, may be conſidered as ſuch for every human purpoſe. It is meaſured obviouſly, but unequally, by the departure of a given meridian from the ſun, and its return to it, conſtituting a ſolar day. Throwing together the inequalities of ſolar days, a mean interval, or day, has been found, and divided, by very general conſent, into 86,400 equal parts.

A PENDULUM, vibrating freely, in ſmall and equal arcs, may be ſo adjuſted in its length, as, by its vibrations, to make this diviſion of the earth's motion into 86,400 equal parts, called ſeconds of mean time.

Such a Pendulum then, becomes itſelf a meaſure of determinate length, to which all others may be referred, as to a ſtandard.

But even the Pendulum is not without its uncertainties.

1. The difficulty of aſcertaining in practice its center of oſcillation, as depending on the form of the bob, and its diſtance from the point of ſuſpenſion; the effect of the weight of the ſuſpending wire towards diſplacing the center of oſcillation; that center being ſeated within the body of the bob, and, therefore, inacceſſible to the meaſure, are ſources of conſiderable uncertainty.

2. Both theory and experience prove, that to preſerve its iſochroniſm, it muſt be ſhorter towards the equator, and longer towards the poles.

3. The height of the ſituation above the common level, as being an increment to the radius of the earth, diminiſhes the length of the Pendulum.

4. The Pendulum being made of metal, as is beſt, it varies its length with the variations in the temperature of the atmoſphere.

5. To continue ſmall and equal vibrations, through a ſufficient length of time, and to count theſe vibrations, machinery and a power are neceſſary, which may exert a ſmall, but conſtant effort to renew the waſte of motion: And the difficulty is, ſo to apply theſe, as that they ſhall neither retard nor accelerate the vibrations.

1. In order to avoid the uncertainties which reſpect the center of oſcillation, it has been propoſed by Mr. Leſlie, an ingenious artiſt of Philadelphia, to ſubſtitute, for the pendulum, an uniform cylindrical rod, without a bob.

Could the diameter of ſuch a bob be infinitely ſmall, the center of oſcillation would be exactly at two thirds of the whole length, meaſured from the point of ſuſpenſion. Giving it a diameter which ſhall render it ſufficiently inflexible, the center will be diſplaced, indeed; but, in a ſecond rod not the (1.) 600,000th part of its length, and not the hundredth part as much as in a ſecond Pendulum, with a ſpherical bob of proper diameter. This diſplacement is ſo infinitely minute then, that we may conſider the center of oſcillation, for all practical purpoſes, as reſiding at two thirds of the length, from the center of ſuſpenſion. The diſtance between theſe two centers might be eaſily and accurately aſcertained in practice. But the whole rod is better for a ſtandard, than any portion of it, becauſe ſenſibly defined at both its extremities.

2. THE uncertainty ariſing from the difference of length requiſite for the ſecond Pendulum, or the ſecond rod, in different latitudes, may be avoided by fixing on ſome one latitude, to which our ſtandard ſhall refer. That of 38°, as being the middle latitude, of the United States, might ſeem the moſt convenient, were we to conſider ourſelves alone; but connected with other nations by commerce and ſcience, it is better to fix on that parallel which bids faireſt to be adopted by them alſo. The 45th, as being the middle term between the equator and pole has been heretofore propoſed in Europe; and the propoſition has been lately renewed there, under circumſtances which may very poſſibly give it ſome effect. This parallel

lel is diſtinguiſhed with us alſo, as forming our principal Northern Boundary. Let the completion of the 45th degree then give the ſtandard for our union, with the hope that it may become a line of union with the reſt of the world.

The difference between the ſecond rod for 45° of latitude, and that for 31° our other extreme, is to be examined.

The ſecond *pendulum* for 45° of latitude, according to Sir Iſaac Newton's computation, muſt be of (2.) 39.14912 inches Engliſh meaſure; and a *rod*, to vibrate in the ſame time, muſt be of the ſame length between the centers of ſuſpenſion and oſcillation, and, conſequently, its whole length 58.7 (or more exactly 58.72368) inches. This is longer than the rod which ſhall vibrate ſeconds in 31° of latitude, by about $\frac{1}{679}$ part of its whole length; a difference ſo minute that it might be neglected, as inſenſible, for the common purpoſes of life: But in caſes requiring perfect exactneſs, the ſecond rod, found by trial of its vibrations in any part of the United States, may be corrected by computation for the (3.) latitude of the place, and ſo brought exactly to the ſtandard of 45°.

3. By making the experiment in the level of the ocean, the difference will be avoided, which a higher poſition might occaſion.

4. The expanſion and contraction of the rod with the change of temperature is the fourth ſource of uncertainty before mentioned. According to the high authority ſo often quoted, an iron rod, of given length, may vary, between ſummer and winter, in temperate latitudes, and in the common expoſure of houſe clocks, from $\frac{1}{1728}$ to $\frac{1}{2592}$ of its whole length, which, in a rod of 58.7 inches, will be from about two, to three hundredths of an inch. This may be avoided by adjuſting and preſerving the ſtandard in a cellar, or other place, the temperature of which never varies. Iron is named for this purpoſe becauſe the leaſt expanſible of the metals.

5. The practical difficulty reſulting from the effect of the machinery and moving power, is very inconſiderable in the preſent ſtate of the arts; and,

in their progreſs towards perfection, will become leſs and leſs. To eſtimate and obviate this, will be the artiſt's province. It is as nothing when compared with the ſources of inaccuracy hitherto attending meaſures.

Before quitting the ſubject of the inconveniencies, ſome of which attend the pendulum alone, others, both the pendulum and rod, it muſt be added that the rod would have an accidental, but very precious advantage over the pendulum in this country, in the event of our fixing the foot at the neareſt aliquot part of either; for the difference between the common foot and thoſe ſo to be deduced, would be three times greater in the caſe of the pendulum, than in that of the rod.

Let the ſtandard of meaſure then be an uniform cylindrical rod of iron, of ſuch length, as, in latitude 45° in the level of the ocean, and in a cellar, or other place, the temperature of which does not vary through the year, ſhall perform its vibrations, in ſmall and equal arcs, in one ſecond of mean time.

A STANDARD of invariable length being thus obtained, we may proceed to identify, by that, the Meaſures, Weights, and Coins of the United States: But here a doubt preſents itſelf, as to the extent of the reformation meditated by the Houſe of Repreſentatives. The experiment made by Congreſs in the year 1786, by declaring that there ſhould be one money of account and payment through the United States, and that its parts and multiples ſhould be in a decimal ratio, has obtained ſuch general approbation, both at home and abroad, that nothing ſeems wanting, but the actual coinage, to baniſh the diſcordant pounds, ſhillings, pence, and farthings of the different ſtates, and to eſtabliſh in their ſtead, the new denominations. Is it in contemplation with the Houſe of Repreſentatives to extend a like improvement to our Meaſures and Weights, and to arrange them alſo in a decimal ratio? The facility which this would introduce into the vulgar arithmetic, would, unqueſtionably, be ſoon and ſenſibly felt by the whole maſs of the people, who would thereby be enabled to compute for themſelves whatever they ſhould have occaſion to buy, to ſell, or to meaſure, which the preſent complicated and difficult ratios place beyond their computation, for the moſt part. Or, is it the opinion of the Repreſentatives that the difficulty of changing the eſtabliſhed habits of a whole nation oppoſes an inſuperable bar to this improvement? Under this uncertainty the Secretary of State thinks it his duty to ſubmit alternative plans, that the Houſe may, at their will, adopt either the one or the other, excluſively, or the one for the preſent, and the other for a future time, when the public mind may be ſuppoſed to have became familiarized to it.

I.

AND firſt, on the ſuppoſition that the preſent Meaſures and Weights, are to be retained, but to be rendered uniform and invariable, by bringing them to the ſame invariable ſtandard.

THE firſt ſettlers of theſe States, having come chiefly from England, brought with them the Meaſures and Weights of that country. Theſe alone are generally eſtabliſhed among us, either by law or uſage, and theſe, therefore, are alone to be retained and fixed. We muſt reſort to that country for information of what they are, or ought to be.

THIS reſts, principally, on the evidence of certain ſtandard Meaſures and Weights, which have been preſerved of long time in different depoſits. But differences among theſe having been known to exiſt, the Houſe of Commons, in the years 1757 and 1758, appointed Committees to inquire into the original ſtandards of their Weights and Meaſures. Theſe Committees, aſſiſted by able mathematicians, and artiſts, examined and compared with each other, the ſeveral ſtandard Meaſures and Weights, and made reports on them in the years 1758 and 1759. The circumſtances under which theſe reports were made, entitle them to be conſidered, as far as they go, as the beſt written teſtimony exiſting, of the ſtandard Meaſures and Weights of England; and as ſuch, they will be relied on in the progreſs of this report.

MEASURES OF LENGTH.

THE Meaſures of Length in uſe among us are,
The League of 3 miles;
The Mile of 8 furlongs;
The Furlong of 40 poles or perches;
The Pole or Perch of 5½ yards;
The Fathom of 2 yards;
The Ell of a yard and quarter;
The Yard of 3 feet;
The Foot of 12 inches;
And the Inch of 10 Lines.

ON this branch of their ſubject the Committee of 1757, 1758, ſays that the ſtandard Meaſures of length at the receipt of the Exchequer, are a yard, ſuppoſed to be of the time of H. 7. and a yard and ell ſuppoſed to have been made about the year 1601, that they are braſs rods, very coarſely made, their diviſions not exact, and the rods bent: and that in the year 1742, ſome members of the Royal Society had been at great pains in taking an exact meaſure of theſe ſtandards, by very curious inſtruments, prepared by the ingenious Mr. Graham, that the Royal Society had had a braſs rod made purſuant to their experiments, which was made ſo accurately, and by perſons ſo ſkilful and exact, that it was thought not eaſy to obtain a more exact one; and the Committee in fact found it to agree with the ſtandards at the Exchequer, as near as it was poſſible. They furniſh no means, to perſons at a diſtance, of knowing what this ſtandard is. This however, is ſupplied by the evidence of the ſecond Pendulum, which, according to the authority before quoted, is, at London, 39.1682 Engliſh inches, and conſequently, the ſecond rod, there, is of 58.7523 of the ſame inches. When we ſhall have found, then, by actual trial, the ſecond rod for 45° by adding the difference of their computed length, to wit $\frac{287}{10,000}$ of an inch, or rather $\frac{1}{3}$ of a line (which in practice will endanger leſs error, than an attempt at ſo minute a fraction as the ten thouſandth parts of an inch) we ſhall have the ſecond rod of London, or a true meaſure of 58$\frac{3}{4}$ Engliſh inches. Or, to ſhorten the operation, without varying the reſult, LET the ſtandard rod of 45° be divided into 587⅕ equal parts and let each of theſe parts be declared a line;

10 Lines an inch;
12 Inches a foot;
3 Feet a yard;
3 Feet 9 Inches an Ell;
6 Feet a Fathom:
5½ Yards a perch or pole;
40 Poles or Perches a furlong;
8 Furlongs a mile;
3 Miles a League.

SUPERFICIAL MEASURES.

OUR meaſures of ſurface are the Acre of 4 rood; and the Rood of 40 ſquare poles; ſo eſtabliſhed by a ſtatute of 33 E. 1. Let them remain the ſame.

MEASURES OF CAPACITY.

The meaſures of Capacity in uſe among us, are of the following names, and proportions.

The gill, 4 of which make a pint;
2 Pints make a quart;
2 Quarts a pottle;

2 Pottles a gallon;
2 Gallons a peck, dry-meaſure;
8 Gallons make a meaſure called a firkin, in liquid ſubſtances, and a buſhel, dry;
2 Firkins or buſhels, make a meaſure called a rundlet, or kilderkin, liquid, and a ſtrike, dry;
2 Kilderkins, or ſtrikes make a meaſure called a barrel, liquid, and a coomb, dry; this laſt term being ancient and little uſed;
2 Barrels, or coombs make a meaſure called a hogſhead, liquid, or a quarter, dry; each being the quarter of a ton;
A Hogſhead and a third make a tierce, or third of a ton;
2 Hogſheads make a pipe, butt, or puncheon,
And 2 Pipes make a ton.

But no one of theſe meaſures is of a determinate capacity. The report of the committee of 1757—8 ſhews that the gallon is of very various content: and that being the unit, all the others muſt vary with it.

THE Gallon and Buſhel contain

224 and 1792 cubic inches, according to the ſtandard wine gallon preſerved at Guildhall;

231 and 1848, according to the ſtatute of the 5th. Anne;

264.8 and 2118.4 according to the ancient Rumford quart of 1228, examined by the committee;

265.5 and 2124, according to three ſtandard buſhels preſerved in the Exchequer, to wit, one of H. 7. without a rim, one dated 1091 ſuppoſed for 1591, or 1601, and one dated 1601.

266.25 and 2130 according to the ancient Rumford gallon of 1228, examined by the committee;

268.75 and 2150 according to the Wincheſter buſhel, as declared by ſtatute 13. 14. W. 3. which has been the model for ſome of the grain ſtates;

271. leſs 2 ſpoonfuls, and 2168, leſs 16 ſpoonfuls, according to a ſtandard gallon of H. 7. and another dated 1601, marked E. E. both in the Exchequer;

271 and 2168, according to a ſtandard gallon in the Exchequer, dated 1601, marked E. and called the corn-gallon;

272 and 2176, according to the three ſtandard corn-gallons laſt mentioned, as meaſured in 1688, by an artiſt for the Commiſſioners of the Exciſe, generally uſed in the ſeaport towns, and by mercantile people, and thence introduced into ſome of the grain ſtates;

277.18 and 2217.44, as eſtabliſhed for the meaſure of coal by the ſtatute 12 Anne;

278, and 2224, according to a ſtandard buſhel of H. 7. with a copper rim, in the Exchequer;

278.4 and 2227.2	according to two ſtandard pints of 1601, and 1602, in the Exchequer;
280, and 2240,	according to the ſtandard quart of 1601, in the Exchequer;
282, and 2256,	according to the ſtandard gallon for beer and ale, in the Treaſury;

THERE are moreover, varieties on theſe varieties, from the barrel to the ton incluſive: for, if the barrel be of herrings, it muſt contain 28 gallons by the ſtatute 13. El. c. 11. If of wine, it muſt contain 31½ gallons by the Statute 2. H. 6. c. 11. and 1. R. 3. c. 15. If of beer or ale, it muſt contain 34 gallons by the ſtatute 1. W. and M. c. 24. and the higher meaſures in proportion.

IN thoſe of the United States which have not adopted the ſtatutes of W. and M. and of Anne before cited, nor their ſubſtance, the wine gallon of 231 cubic inches reſts on the authority of very long uſage before the 5th. of Anne, the origin and foundation of which are unknown; the buſhel is the Wincheſter buſhel, by the 11. H. 7. undefined; and the barrel of ale 32 gallons, and of beer 36 gallons by the ſtatute 23. H. 8. c. 4.

THE Secretary of State is not informed whether there have been any and what alterations of theſe meaſures, by the laws of the particular States.

IT is propoſed to retain this ſeries of meaſures, but to fix the gallon to one determinate capacity, as the unit of meaſure, both wet and dry; for convenience is in favour of aboliſhing the diſtinction even between wet and dry meaſures.

THE wine gallon, whether of 224 or 231 cubic inches, may be altogether diſregarded, as concerning, principally, the mercantile, and the wealthy, the leaſt numerous part of the ſociety, and the moſt capable of reducing one meaſure to another by calculation. This gallon is little uſed among the maſs of farmers, whoſe chief habits and intereſts are in the ſize of the corn buſhel.

OF the ſtandard meaſures before ſtated, two are principally diſtinguiſhed in authority and practice. The ſtatute buſhel of 2150 cubic inches, which gives a gallon of 268.75 cubic inches, and the ſtandard gallon of 1601, called the corn gallon of 271, or 272 cubic inches, which has introduced the mercantile buſhel of 2176 inches. The former of theſe is moſt uſed in ſome of the grain ſtates, the latter in others. The middle term of 270 cubic inches may be taken as a mutual compromiſe of convenience, and as offering this general advantage, that the buſhel being of 2160 cubic inches, is exactly a cubic foot and a quarter, and ſo facilitates the converſion of wet and dry meaſures into ſolid contents and tonnage, and ſimplifies the connection of meaſures and weights, as will be ſhewn hereafter. It may be added in favor of this, as a medium meaſure, that eight of the ſtandard or ſtatute meaſures before enumerated, are below this term, and nine above it.

The meaſures to be made for uſe, being four-ſided, with rectangular ſides and bottom,

The Pint will be 3 inches ſquare and 3¾ inches deep;
The Quart 3 inches ſquare and 7½ inches deep;
The Pottle 3 inches ſquare and 15 inches deep, or 4½, 5, and 6, inches;

The Gallon 6 inches ſquare and 7½ inches deep,
or 5, 6, and 9 inches;
The Peck 6, 9, and 10 inches;
The Half-buſhel 12 inches ſquare, and 7½
inches deep; and
The Buſhel 12 inches ſquare, and 15 inches
deep, or 9, 15, and 16 inches.

CYLINDRICAL meaſures have the advantage of ſuperior ſtrength: but ſquare ones have the greater advantage of enabling every one, who has a rule in his pocket, to verify their contents, by meaſuring them. Moreover, till the circle can be ſquared, the cylinder cannot be cubed, nor it's contents exactly expreſſed in figures.

LET the meaſures of capacity then, for the United States, be,

A Gallon of 270 cubic inches;
The Gallon to contain two pottles;
The Pottle 2 quarts;
The Quart 2 pints;
The Pint 4 gills.
2 Gallons to make a peck;

8 Gallons a buſhel or firkin;
2 Buſhels or firkins, a ſtrike or kilderkin;
2 Strikes, or kilderkins a coomb, or barrel;
2 Coombs, or barrels a quarter or hogſhead;
A Hogſhead and a third, one tierce;
2 Hogſheads a pipe, butt or puncheon; and
2 Pipes a ton.

AND let all meaſures of capacity of dry ſubjects be ſtricken with a ſtrait ſtrike.

WEIGHTS.

THERE are two ſeries of Weights in uſe among us; the one called Avoirdupois, the other Troy.

IN the Avoirdupois ſeries,

The Pound is divided into 16 ounces;
The Ounce into 16 drams;
The Dram into 4 quarters.

IN the Troy ſeries,

The Pound is divided into 12 ounces;
The Ounce (according to the ſubdiviſion of the Apothecaries) into 8 drams;

The Dram into 3 ſcruples;
The Scruple into 20 grains.

According to the ſubdiviſion for gold and ſilver, the ounce is divided into 20 penny-weight; and the penny-weight into 24 grains.

So that the pound Troy contains 5760 grains, of which, 7,000 are requiſite to make the pound Avoirdupois; of courſe the weight of the pound Troy, is to that of the pound Avoirdupois as 5760 to 7,000, or, as 144 to 175.

It is remarkable that this is exactly the proportion of the ancient liquid gallon of Guildhall of 224 cubic inches, to the corn gallon of 272. for 224 are to 272, as 144 to 175. (4.)

It is further remarkable ſtill, that this is alſo the exact proportion between the ſpecific weight of any meaſure of wheat, and of the ſame meaſure of water. For the ſtatute buſhel is of 64 pounds of wheat. Now as 144 to 175, ſo are 64lb. to 77.7lb. but 77.7lb. is known to be the weight of (5.) 2150.4 cubic inches of pure water; which

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which is exactly the content of the Wincheſter buſhel, as declared by the ſtatute 13. 14. W. 3. That ſtatute determined the buſhel to be a cylinder of 18½ inches diameter, and 8 inches depth. Such a cylinder, as nearly as it can be cubed, and expreſſed in figures, contains 2150.425 cubic inches: a reſult which reflects authority on the declaration of Parliament, and induces a favourable opinion of the care with which they inveſtigated the contents of the ancient buſhel, and alſo a belief that there might exiſt evidence of it at that day, unknown to the committees of 1758, and 1759.

We find then in a continued proportion 64 to 77.7 as 224 to 272, and as 144 to 175, that is to ſay, the ſpecific weight of a meaſure of wheat, to that of the ſame meaſure of water, as the cubic contents of the wet-gallon, to thoſe of the dry; and as the weight of a pound Troy to that of a pound Avoirdupois.

This ſeems to have been ſo combined as to render it indifferent whether a thing were dealt out by weight or meaſure, for the dry gallon of wheat, and the liquid one of wine were of the ſame weight; and the Avoirdupois pound of wheat, and the Troy pound of wine, were of the ſame meaſure. Water and the vinous liquors, which enter moſt into commerce, are ſo nearly of a weight, that the difference, in moderate quantities, would be neglected by both buyer and ſeller; ſome of the wines being a little heavier, and ſome a little lighter than water.

ANOTHER remarkable correſpondence, is that between weights and ſolid meaſures. For 1000 ounces Avoirdupois of pure water, fill a cubic foot, with mathematical exactneſs.

WHAT circumſtances of the times or purpoſes of barter, or commerce, called for this combination of weights and meaſures, with the ſubjects to be exchanged or purchaſed, are not now to be aſcertained. But a triple ſet of exact proportionals repreſenting weights, meaſures, and the things to be weighed and meaſured, and a relation ſo integral between weights, and ſolid meaſures, muſt have been the reſult of deſign and ſcientific calculation, and not a mere coincidence of hazard. It proves that the dry, and wet meaſures, the heavy and light weights, muſt have been original parts of the ſyſtem they compoſe: contrary to the opinion of the committee of 1757—1758, who thought that the Avoirdupois weight was not an ancient weight of the kingdom, nor ever even a legal weight, but during a ſingle year of the reign of H. 8. and therefore, concluded, otherwiſe than will be here propoſed, to ſuppreſs it altogether. Their opinion was founded chiefly on the ſilence of the laws, as to this weight. But the harmony here developed in the ſyſtem of weights and meaſures, of which the Avoirdupois makes an eſſential member, corroborated by a general uſe, from very high antiquity, of that, or of a nearly ſimilar weight under another (6.) name, ſeem ſtronger proofs that this is a legal weight, than the mere ſilence of the written laws is of the contrary.

Be this as it may, it is in ſuch general uſe with us, that, on the principle of popular convenience, it's higher denominations, at leaſt, muſt be preſerved. It is by the Avoirdupois pound and ounce that our citizens have been uſed to buy and ſell. But the ſmaller ſubdiviſions of drams and quarters, are not in uſe with them. On the other hand, they have been uſed to weigh their money and medicine with the penny-weights and grains troy-weight, and are not in the habit of uſing the pounds and ounces of that ſeries. It would be for their convenience, then, to ſupproſs the pound and ounce troy, and the dram and quarter Avoirdupois; and to form into one ſeries the Avoirdupois pound and ounce, and the troy penny-weight and grain. The Avoirdupois ounce contains 18 penny-weight 5½ grains troy-weight Divide it then into 18 penny-weight, and the penny-weight, as heretofore, into 24 grains, and the new penny-weight will contain between a third and a quarter of a grain more than the preſent troy penny-weight; or, more accurately, it will be to that, as 875 to 864, a difference not to be noticed, either in money or medicine, below the denomination of an ounce.

But it will be neceſſary to refer theſe weights to a determinate maſs of ſome ſubſtance, the ſpecific gravity of which is invariable. Rain-water is ſuch a ſubſtance, and may be referred to every where, and through all time. It has been found by accurate experiments, that a cubic foot of rain-water weighs 1000 ounces Avoirdupois, ſtandard weights of the Exchequer. It is true that among theſe ſtandard weights, the committee reports ſmall variations; but this experiment muſt decide in favour of thoſe particular weights, between which and an integral maſs of water, ſo remarkable a coincidence has been found. To render this ſtandard more exact, the water ſhould be weighed always in the ſame temperature of air, as heat, by increaſing it's volume, leſſens it's ſpecific gravity. The cellar of uniform temperature, is beſt for this alſo.

LET it, then, be eſtabliſhed that an ounce is of the weight of a cube of rain-water, of one tenth of a foot, or rather, that it is the thouſandth part of the weight of a cubic foot of rain-water, weighed in the ſtandard temperature: that the ſeries of weights of the United States ſhall conſiſt of pounds, ounces, penny-weights, and grains; whereof

24 Grains ſhall be one penny-weight;
18 Penny-weight one ounce;
16 Ounces one pound.

C O I N S.

Congress in 1786 eſtabliſhed the money unit at 375.64 troy grains of pure ſilver. It is propoſed to enlarge this by about the third of a grain, in weight, or a mill, in value; that is to ſay, to eſtabliſh it at 376 (or more exactly 376.029 85) inſtead of 375.64 grains, becauſe it will be ſhewn that this, as the unit of coin, will link in ſyſtem with the units of length, ſurface, capacity, and weight, whenever it ſhall be thought proper to extend the decimal ratio through all theſe branches. It is to preſerve the poſſibility of doing this, that this very minute alteration is propoſed.

We have this proportion then, 875 to 864 as 376.029 85 grains troy to 371.30261, the expreſſion of the unit in the new grains.

LET it be declared, therefore, that the money unit, or dollar of the United States, ſhall contain 371.3 American grains of pure ſilver.

IF nothing more then, is propoſed than to render uniform and ſtable the ſyſtem we already poſſeſs, this may be effected on the plan herein detailed; the ſum of which is, 1. That the preſent meaſures of length be retained and fixed by an invariable ſtandard: 2. That the meaſures of ſurface remain as they are, and be invariable alſo as the meaſures of length to which they are to refer: 3. That the unit of capacity, now ſo equivocal, be ſettled at a medium and convenient term, and defined by the ſame invariable meaſures of length: 4. That the more known terms in the two kinds of weights be retained, and reduced to one ſeries, and that they be referred to a definite maſs of ſome ſubſtance, the ſpecific gravity of which never changes: And 5. That the quantity of pure ſilver in the money unit be expreſſed in parts of the weights ſo defined.

IN the whole of this no change is propoſed, except an inſenſible one in the troy grain and pennyweight, and the very minute one in the money unit.

II.

But if it be thought that, either now, or at any future time, the citizens of the United States may be induced to undertake a thorough reformation of their whole ſyſtem of Meaſures, Weights and Coins, reducing every branch to the ſame decimal ratio already eſtabliſhed in their Coins, and thus bringing the calculation of the principal affairs of life within the arithmetic of every man who can multiply and divide plain numbers, greater changes will be neceſſary.

The unit of Meaſure is ſtill that which muſt give law through the whole ſyſtem: And from whatever unit we ſet out, the coincidencies between the old and new ratios will be rare. All that can be done will be to chuſe ſuch an unit as will produce the moſt of theſe. In this reſpect the ſecond rod has been found, on trial, to be far preferable to the ſecond pendulum.

Measures of Length.

Let the ſecond rod, then, as before deſcribed, be the ſtandard of Meaſure; and let it be divided into five equal parts, each of which ſhall be called a FOOT : For, perhaps, it may be better generally to retain the name of the neareſt preſent Meaſure, where there is one tolerably near. It will be about one quarter of an inch ſhorter than the preſent foot.

Let the Foot be divided into 10 inches ;
the Inch into 10 lines ;
the Line into 10 points ;
Let 10 Feet make a decad ;
10 Decads a rood ;
10 Roods a furlong ;
10 Furlongs a mile ;

SUPERFICIAL MEASURES.

SUPERFICIAL Meaſures have been eſtimated, and ſo may continue to be, in ſquares of the meaſures of length, except in the caſe of lands, which have been eſtimated by ſquares, called roods and acres. Let the rood be equal to a ſquare, every ſide of which is 100 feet. This will be 6.483 Engliſh feet leſs than the Engliſh (7) rood every way, and 1311 ſquare feet leſs in its whole contents, that is to ſay, about one eighth, in which proportion alſo 4 rood will be leſs than the preſent acre.

MEASURES OF CAPACITY.

LET the unit of capacity be the cubic foot, to be called a buſhel. It will contain 1620.23 cubic inches, Engliſh; be about $\frac{1}{4}$ leſs than that before propoſed to be adopted as a medium; $\frac{1}{10}$ leſs than the buſhel made from 8 of the Guildhall gallons; and $\frac{1}{14}$ leſs than the buſhel made from 8 Iriſh gallons of 217.6 cubic inches.

LET the buſhel be divided into 10 pottles;
each Pottle into 10 demi-pints;
each Demi-pint into 10 metres, which will be of a cubic inch each.
LET 10 buſhels be a quarter, and
10 Quarters a laſt, or double-ton.

THE meaſures for uſe being fourſided, and the ſides and bottoms rectangular, the buſhel will be a foot cube;

The Pottle 5 inches ſquare and 4 inches deep;
The Demi-pint 2 inches ſquare, and $2\frac{1}{2}$ inches deep;
The Metre, an inch cube.

WEIGHTS.

LET the weight of a cubic inch of rain-water, or the thouſandth part of a cubic foot, be called an ounce; and let the ounce be divided into 10 double ſcruples;

the Double ſcruple into 10 carats;
the Carat into 10 minims, or demi-grains;
the Minim into 10 mites.

LET 10 Ounces make a pound;
10 Pounds a ſtone;
10 Stone a kental;
10 Kental a hogſhead.

COINS.

LET the money-unit, or dollar contain eleven twelfths of an ounce of pure ſilver. This will be 376 troy grains (or more exactly 376.02985 troy grains) which

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which will be about a third of a grain (or more exactly, .38985 of a grain) more than the preſent unit. This with the twelfth of alloy, already eſtabliſhed, will make the dollar or unit, of the weight of an ounce, or of a cubic inch of rain-water, exactly. The ſeries of mills, cents, dimes, dollars, and eagles to remain as already eſtabliſhed (8.)

THE ſecond rod, or the ſecond pendulum, expreſſed in the meaſures of other countries, will give the proportion between their meaſures and thoſe of the United States.

MEASURES, weights and coins thus referred to ſtandards unchangeable in their nature (as is the length of a rod vibrating ſeconds, and the weight of a definite maſs of rain water) will themſelves be unchangeable. Theſe ſtandards too are ſuch as to be acceſſible to all perſons, in all times and places. The meaſures and weights derived from them, fall in ſo nearly with ſome of thoſe now in uſe, as to facilitate their introduction; and, being arranged in decimal ratio, they are within the calculation of every one who poſſeſſes the firſt elements of arithmetic, and of eaſy compariſon, both for foreigners and citizens, with the meaſures, weights and coins of other countries.

A GRADUAL introduction would leſſen the inconveniences which might attend too ſudden a ſubſtitution, even of an eaſier, for a more difficult ſyſtem. After a given term, for inſtance, it might begin in the cuſtom-houſes, where the merchants would become familiariſed to it. After a further term, it might be introduced into all legal proceedings; and merchants and traders in foreign commodities might be required to uſe it in their dealings with one another. After a ſtill further term all other deſcriptions of people might receive it into common uſe. Too long a poſtponement, on the other hand, would increaſe the difficulties of its reception with the increaſe of our population.

Thomas Jefferſon,
Secretary of State.

APPENDIX:

Containing ILLUSTRATIONS *and* DEVELOPEMENTS *of ſome Paſſages of the preceding Report.*

(1.) IN the ſecond pendulum with a ſpherical bob, call the diſtance between the centers of ſuſpenſion, and of the bob, 2 × 19.575, or 2d. and the radius of the bob =r. then 2d : r : : r : $\frac{rr}{2d.}$ and $\frac{2}{5}$ of this laſt proportional expreſſes the diſplacement of the center of oſcillation, to wit, $\frac{2rr}{5\times 2d} = \frac{rr}{5d.}$ Two inches have been propoſed as a proper diameter for ſuch a bob. In that caſe r. will be = 1. inch, and $\frac{rr}{5d} = \frac{1}{97.57}$ inches.

IN the cylindrical ſecond rod, call the length of the rod 3×19.575, or 3d. and its radius =r. and $\frac{rr}{2\times 3d} = \frac{rr}{6d}$ will expreſs the diſplacement of the center of oſcillation. It is thought the rod will be ſufficiently inflexible if it be $\frac{1}{5}$ of an inch in diameter. Then r. will be =.1 inch, and $\frac{rr}{6d} = \frac{1}{11745}$ inches, which is but the 120th part of the diſplacement in the caſe of the pendulum, with a ſpherical bob; and but the 689,710th part of the whole length of the rod. If the rod be even of half an inch diameter, the diſplacement will be but $\frac{1}{1879}$ of an inch, or $\frac{1}{110356}$ of the length of the rod.

(2.) Sir Iſaac Newton computes the pendulum for 45° to be 36 pouces 8.428 lignes. Picard made the Engliſh foot 11 pouces 2.6 lignes, and Dr. Maſkelyne 11 pouces 3.11 lignes. D'Alembert ſtates it at 11 pouces 3 lignes, which has been uſed in theſe calculations as a middle term, and gives us $\overset{\text{Pouces.}}{36}\ \overset{\text{Lignes.}}{8.428} = 39.1491$ inches. This length for the pendulum of 45° had been adopted in this report before the Biſhop of Autun's propoſition was known here. He relies on Mairan's ratio for the length of the pendulum in the latitude of Paris, to wit, 504 : 257 : : 72 pouces to a 4th proportional, which will be $\overset{\text{Pouces.}}{36.71428} = 39.1619$ inches, the length of the pendulum for latitude 48° 50′. The difference between this and the pendulum for 45° is .0113 of an inch: So that the pendulum for 45° would be eſtimated, according to

Mairan at 39.1619—.0113=39.1506 inches, almoſt preciſely the ſame with Newton's computation herein adopted.

(3.) Sir Iſaac Newton's computations for the different degrees of latitude from 30° to 45°, are as follows:

	Pieds.		*Lignes.*		*Pieds.*		*Lignes.*
30°	3	-	7.948	42°	3	-	8.327
35	3	-	8.099	43	3	-	8.361
40	3	-	8.261	44	3	-	8.394
41	3	-	8.294	45	3	-	8.428

(4.) or more exactly $144 : 175 :: 224 : 272.\dot{2}$

(5.) or more exactly $62.5 : 1728 :: 77.\dot{7} : 2150.3\dot{9}$

(6.) the merchant's weight.

(7.) The Engliſh rood contains 10890 ſquare feet =104.355 feet ſquare,

(8.) The Meaſures, Weights and Coins of the decimal ſyſtem, eſtimated in thoſe of England, now uſed in the United States.

1. Mea-

1. MEASURES OF LENGTH.

	Feet.	Equivalent in Engliſh Meaſure.
The *Point*	·001	.011 inches.
Line	.01	.117
Inch	.1	1.174 about $\frac{1}{7}$ more than the Engliſh inch.
Foot	1.	11.744736 ·978728 feet, about $\frac{1}{48}$ leſs than the Engliſh foot.
Decad	10.	9·787 about $\frac{1}{48}$ leſs than the 10 feet rod of the carpenters.
Rood	100.	97.872 about $\frac{1}{16}$ leſs than the ſide of an Engliſh ſquare rood.
Furlong	1000.	978·728 about $\frac{1}{3}$ more than the Engliſh furlong.
Mile	10000.	9787.28 about $1\frac{6}{7}$ Engliſh mile, nearly the Scotch and Iriſh mile, and $\frac{1}{2}$ the German mile.

2. SUPERFICIAL MEASURE.

	Rood.	Square feet.
The *Rood*	1.	9579·085 about $\frac{1}{8}$ leſs than the Engliſh rood.

3. MEASURES OF CAPACITY.

	Buſhels.	Cub. inches.
The *Metre*	.001	1.6202
Demipint	.01	16 202 about $\frac{1}{24}$ leſs than the Engliſh half pint.
Pottle	1	162.022 about $\frac{1}{6}$ more than the Engliſh pottle.
Buſhel	1.	1620.22959662092016025б .937632868414884352 cub. feet. about $\frac{1}{4}$ leſs than the middle ſized Engliſh buſhel.
Quarter	10.	9·376 about $\frac{1}{5}$ leſs than the Engliſh quarter.
Laſt	100	93·763 about $\frac{1}{7}$ more than the Engliſh laſt.

4. WEIGHTS.

	Pounds.	Avoirdupois.	Troy.
The *Mite*	.00001	- - -	.041 grains about $\frac{1}{5}$ leſs than the Engliſh mite.
Minim or Demigrain	.0001	- - -	.4102 about $\frac{1}{5}$ leſs than the half grain Troy.
Carat	.001	- - -	4.102 about $\frac{1}{40}$ more than the carat Troy.
Double Scruple	.01	- - -	41.021 about $\frac{1}{40}$ more than 2 ſcruples Troy.
Ounce	.1	.937632868414884352 oz.	410.2143799315119 04 about $\frac{1}{16}$ leſs than .85461 oz. the ounce Avoir.
Pound	1.	9.376 .586020540093 lb.	.712175 lb. about $\frac{1}{4}$ leſs than the pound Troy.
Stone	10.	93.763 oz. 5.8602 lb.	7.121 about $\frac{1}{4}$ leſs than the Engliſh ſtone of 8 lb. Avoirdupois.
Kental	100.	937.632 oz. 58.602 lb.	71.217 about $\frac{4}{10}$ leſs than the Engliſh Kental of 100 lb. Avoirdupois.
Hogſhead	1000.	9376.328 oz. 586.0205 lb.	712.175

5. COINS.

	Dollars.
The *Mill*	.001
Cent	.01
Dime	.1

		Troy grains.
The *Dollar*	1.	376.02985 Pure ſilver. 34.18453 alloy. 410.21438
Eagle	10.	